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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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In the Matter of	)	
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Federal-State Joint Board on Universal Service	)	CC Docket No. 96-45
	)	
	)	
Forward-Looking Mechanism for High Cost Support for Non-Rural LEC's	)	CC Docket No. 97-160
	)	

AFFIDAVIT OF CHRISTIAN MICHAEL DIPPON
IN SUPPORT OF
GTE'S PETITION FOR RECONSIDERATION
OF THE FIFTH REPORT AND ORDER

I, Christian Michael Dippon, being duly sworn, say:

1. I have been employed at National Economic Research Associates, Inc. ("NERA") for the last two and one half years. As a Senior Economic Analyst for NERA, I work mainly on regulatory cases involving pricing policy and the assessment of competition in the telecommunications industry. I have analyzed cost studies for telecommunications services and elements and determined reasonable TE/TSLRICs that meet competitive standards and are consistent with the Federal Communications Commission's ("Commission") guidelines. In particular, I have analyzed and commented on more than ten versions of the HAI Model (previously called the Hatfield Model), several versions of the Benchmark Cost Proxy Model ("BCPM"), and other industry-sponsored cost models. Most recently, I have been involved in analyzing the different versions of the

Commission staff's first attempts at the Hybrid Cost Proxy Model ("HCPM"). On several of these models, I have prepared testimony and written papers and expert reports. I also have attended industry workshops where I presented the results of my studies. In addition, I have appeared before several state public utilities commissions as a subject matter expert in telecommunications matters. A copy of my resume is attached as Exhibit A.

2. GTE asked me to review the cost proxy model adopted by the FCC on October 28, 1998, in its *Order*,[1] and to provide a preliminary assessment of its suitability for estimating universal service costs. This report presents the findings of my analysis. The analysis was limited because the adopted model is not a fully functional model and is in the process of being finalized.

INTRODUCTION AND SUMMARY

3. Based on a recommendation by the Joint Board, the Commission has been overseeing the development of a cost proxy model for use in estimating forward-looking economic costs for universal service purposes. The Commission considered three models: the BCPM, the HAI Model, and the Commission staff's HCPM,[2] and then adopted a different model. Although the Commission calls the

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[1] Federal-State Board on Universal Service; Forward-Looking Mechanism for High Cost Support for Non-Rural LECs, *Fifth Report and Order*, CC Docket Nos. 96-45, 97-160, FCC 98-279 (rel. Oct. 28, 1998) ("*Order*").

[2] While it may have been a serious contender in the Commission's view, the HCPM was not considered as such by the industry. Further, it was not intensively analyzed like the other models mostly because there was no opportunity to perform a complete analysis and review as there was with the other cost proxy models. Appendix A lists the recent changes to the HCPM/FCC Model and shows why an

model adopted in the *Order* a "synthesized" model (*i.e.*, "the best elements from each of the two industry-sponsored models, along with innovations by Commission staff"),[3] it is a model that has never been subject to public comment or evaluation. It incorporates some very recently modified modules from the HCPM and even more recently modified modules from the HAI Model. Unfortunately, none of the modifications have been fully documented or published by the Commission for review by the public.

4. From an analytical point of view, combining modules from different models creates a new model that needs to be reviewed and tested in its entirety before any conclusions about its validity can be drawn. Limited by the fact that the adopted model ("FCC Model" or "Model") is incomplete,[4] it is impossible to evaluate it as a fully functioning model to determine if it produces reasonable outputs.[5] The adopted model is a work-in-progress, which is missing crucial parts. In addition, as soon as any type of limited analysis is performed, it is outdated by new modifications to the Model.[6]

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analysis was impossible.

[3] "Commission Adopts Model Platform For Use in Determining Universal Service Support for High Cost Areas," FCC News, October 22, 1998, at 2.

[4] As discussed in this document and in the *Order* (at ¶ 13), the FCC Model is still being modified to comply with the *Order* and currently is missing a customer location database, a full set of input values, and other critical components.

[5] The *Order* was released October 28, 1998, and Petitions for Reconsideration are due December 18, 1998. This is insufficient time to perform an analysis on a model. At a minimum, several months are required after a model is complete to perform the type of analysis required to validate it.

[6] The analysis presented in this report is based on the November 18 version. Another version was issued on December 7, 1998, and yet another on December 15, 1998. Due to time constraints, preliminary incomplete assessments are all that could be performed on the December 7 and December 15 versions' impacts on the analysis.

5. Evaluating a model is a complex process that requires considerable time, effort, and knowledge. For instance, the BCPM and the HAI Model have been subject to intense scrutiny for more than two years. Over approximately the last thirty months, I spent thousands of hours analyzing and writing hundreds of pages of comments on the BCPM and the HAI Model pursuant to the directions of federal and state regulators. The prerequisite for such analysis is that sufficient time is available and that all aspects of the model are made public.[7] In this respect, however, the FCC Model lacks adequate documentation, is missing complete and documented source code, and has other open issues, all of which the Commission must resolve.

6. In addition to the Model not being complete and the lack of time for a thorough analysis, the Model, in its current state, does not appear to be in compliance with the *Order*. This order states that "a model will most fully comply with the *Universal Service Order's* criteria if it designs a network that . . . adheres to sound engineering and forward-looking, cost minimizing principles . . . ."[8] As discussed throughout this affidavit, the current FCC Model, as a whole, does not comply with the *Universal Service Order's*[9] criteria because it does not adhere to forward-looking cost minimizing principles. In addition, as detailed in Francis J. Murphy's affidavit ("Murphy Affidavit") submitted on behalf of GTE in this

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[7] Or, at the least, made available subject to nondisclosure agreements.
[8] *Order* at ¶ 54.
[9] *See* Federal-State Joint Board on Universal Service, *Report and Order*, 12 FCC Rcd 8776 (1997) ("*Universal Service Order*").

proceeding, the FCC Model also does not adhere to sound engineering principles.

7. At a minimum, the Commission should have completed its work on the adopted model and allowed the public a reasonable opportunity to evaluate the model as a whole before adopting it for universal service purposes.

8. Finally, under the constraints outlined above, my preliminary analysis of the FCC Model has revealed a number of questions and concerns that need to be addressed before a conclusion about the Model's validity can be drawn.

A PROPER ANALYSIS OF THE FCC MODEL CANNOT BE MADE.

9. When analyzing the HAI Model, I focused mainly on the economic validity of the model (*i.e.*, how the network was modeled and the accuracy of the model's outputs). In particular, I reviewed HAI's modeling of outside plant, including the customer location database, the clustering algorithms, and the accuracy of the output based on geocoded data. Repeatedly, I commented on the many flaws deeply embedded in HAI's handling of outside plant.

10. Since common costs are integral to the determination of TSLRICs, I also reviewed the method used to determine and allocate these costs in the HAI Model.

11. A model is only as good as the accuracy of its output. Thus, I performed

numerous external validity checks on the HAI Model's output. For instance, using real data from ILECs, I compared the HAI Model's results to the real data. While I do not believe that a model's results should match perfectly with book data, I used this comparison as a check on the type of results being produced. As part of the external validity check, I also performed a minimum spanning tree test (described in detail later in this affidavit) and discovered that the HAI Model accounted for less distribution cable than physically needed to connect customers to the network.

12. The only way that one can be assured that a model is actually doing what its documentation says is to check the model's code. Thus, I spent considerable time going through the HAI Model's code. This is an extremely tedious and time-consuming task, but a necessary one.

13. I analyzed and commented on HAI's handling of switching costs, interoffice and transport costs, and expenses, pointing out the modeling flaws that I found. Regarding expenses, I repeatedly stressed the problems associated with directly linking expenses with investments. I also scrutinized many of HAI's default values for the user-adjustable inputs.

14. I conducted most of the same tests on the BCPM, although in less detail. In particular, I conducted external validity checks and compared the BCPM's results to actual ILEC data. I analyzed the customer location module and generally

found it to be a reasonable approach where, in high density zones, it was at least as accurate as the HAI Model and more accurate in less dense zones.

15. Overall, I have looked through both the HAI Model and the BCPM and checked for reasonable economic principles. I also have performed similar studies on several other cost proxy models submitted at the state and federal level.

16. The above type of analyses must be performed on the FCC Model before any conclusion is reached about its validity. Even though some of the modules have existed in one form or another in other models, the combination of modules that make up the FCC Model has never been presented as a model. Thus, any prior analysis is not necessarily valid, even though it may have been on the same modules. A new analysis must be performed on the FCC Model as a whole. Unfortunately, this type of analysis cannot be performed as the components necessary for a full evaluation do not exist and, even if they did exist, time has not been allowed for such a task.

17. As explicitly discussed in the *Order*,[10] the FCC Model is a work-in-progress and necessary changes will be made by the Common Carrier Bureau. The final Model adopted by the Commission does not exist yet, and the current version is undergoing numerous changes in order to comply with the requirements set out in the *Universal Service Order* and again in the *Order*.

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[10] *Order* at ¶ 13.

18. A cost proxy model is not simply the sum of its modules. The interaction between the modules is as critical to the proper functioning of a cost model as the integrity of the modules. Even if the integrity of each of the modules in the FCC Model was unchallengeable, it is impossible to determine if the Model, as a whole, functions as designed. This is because there is no overall design for this Model. The Commission has selected modules from several different models, ordered changes to some of the modules, and combined them into one, ignoring basic principles of modeling. What is lacking is an architectural model, which "provide[s] guidance as to how the detailed subdomains [modules] should be, ensuring that they work together effectively."[11] Modeling should be a downward process, not upward. The basic design should be completed first and then the modules developed. Instead, the Commission has taken the opposite approach with the FCC Model:

> Just like too many cooks spoil the broth, too many modelers spoil the application. One of the dangers of iterative and incremental development is that people think they can go off and do their own thing and it will all work together. This rarely happens, even when they do a good job on their portion, because when you try to integrate everything it doesn't fit together well because there wasn't a consistent vision from which everything was built.[12]

This aptly describes the FCC Model. Before it adopts any model, the Commission must allow sufficient time for the proper design and integration of all

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[11] Scott W. Ambler, "The Object-Oriented Modeling Process: Process Patterns for an Architecture-Driven Approach," An AmbySoft Inc. White Paper, finalized June 1, 1998, at 3.
[12] *Id.* at 9.

the modules into an overall design. Then, and only then, can the Model be tested and evaluated. Otherwise, time will be wasted on iteration after iteration that likely will not work.

19. The Commission should not adopt a model before it has been validated. As discussed above, in modeling, the sum of the parts does not necessarily make the whole. When the Commission staff has developed an overall design, finished modifying the modules from the different models, and ensured that the Model runs successfully, then the users should be allowed enough time to evaluate the output resulting from what is basically a new model—I say new because none of the components of the FCC Model have ever before been intermingled.

20. Further, although the Commission has decided to separate this proceeding into two stages—platform and inputs—I strongly recommend against such division. A model can only be fully evaluated as a whole.

21. In addition, the revisions made to the FCC Model in recent weeks have made it extremely difficult for the user to review. From the *Order*, it is difficult to determine exactly what the FCC Model will be composed of (*i.e.*, which of the "innovations" to the Model's customer location module listed in Appendix A have been adopted as they currently exist and which have been adopted with modification). In either case, sufficient time has not been permitted for review and evaluation, and documentation on the Model is not adequate.

22. The numerous recent modifications to the FCC Model and its integrated, or interfaced modules, is evidence that the Model is incomplete. The Model currently is missing a customer location database, a full set of input values and several other unresolved issues remain. This poses a problem to the analyst and prohibits a proper analysis of the Model. Most important, the FCC Model has never been made available as a whole. It consists of modified bits and pieces from other models, most of which are not available through the Commission's web site.

23. Customer location data (*e.g.*, the geocode database) is critical to the evaluation and accuracy of a cost proxy model. As the *Order* (at ¶ 34) states, a final geocode database is not yet available and will be determined at the inputs stage of this proceeding. For analytical purposes, the Commission suggests that "[a]t a minimum, PNR's data is now available for review, and interested parties may comment upon and suggest improvements to the accuracy of that database." (*Id.*) Unfortunately, this last statement is not entirely accurate. PNR's data is not publicly available, as discussed in the Affidavit of Robert Clinesmith, filed by GTE.

24. Further, there are major concerns regarding the PNR database. First, currently available geocoded points do not account for unpopulated housing units. To meet the minimum service requirements of most states, unpopulated housing units also must have public network connections readily available. Otherwise, it

would be impossible for carriers of last resort to meet any requirement that service be provided within a certain number of days after the request has been received. Second, the geocoding success rates of the PNR database are extremely low in rural areas—exactly those areas where universal service subsidy requirements are the greatest. Third, we need to be assured that the source of geocoding points and the geocoding process are of high quality. Given the proprietary nature of the PNR database, this is not a certainty.

25. In the absence of a real input database for the FCC Model, the only data that the analyst is left with is the "mock" data for Maryland that was supplied with the Model. Under these circumstances, a full evaluation of the FCC Model is impossible.

26. As discussed throughout this text, Model accuracy and external validation are the cornerstones of any model analysis. Only if a model produces sensible, realistic results should it be considered as a viable option in the efforts to determine the size of the universal service fund. Without an accurate geocoded database, such analysis is impossible.

27. As the FCC explicitly states, the Model currently exists only in a beta version. There are many concerns regarding the model functionality. For example, the documentation is unclear as to the purpose of the Optimization parameter located in the Cost Proxy Model Synthesis window, which makes it impossible to

use the component. This parameter must be described so that users can take advantage of all available options. In addition, the user is unable to select the algorithms, optimization techniques, or input parameters associated with the Clustering Module, unless the program is run in "demo mode." Running the Model in demo mode, however, prevents the user from saving any output files and examining the effects of the different clustering methods. Therefore, no true analysis or sensitivities can be performed.[13]

28. Another reason it is impossible to fully analyze the FCC Model is that the Model's computer code is not fully accessible to the user. A complete analysis of the Model requires full documentation and examination of all model code and components.[14]

29. The documentation for the FCC Model can only be described as incomplete. The absence of clear, complete, and correct documentation severely impedes the evaluation process of this Model. Among many, the following areas require further clarification.

- Chronological details of any changes from version to version. To eliminate

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[13] The December 7 FCC Model release incorporates several new features. Two windows, "Clusintf Options" and Feeddist Options," have replaced the Optimization Parameter and Microgrid Size windows on the HCPM interface. The use of the new windows and available inputs now is documented. The restrictions regarding Clustering Module have been addressed by a set of user-adjustable Cluster Inputs, which allow the user to indicate the desired variables and algorithms to be used by the Clustering Module. There has not been sufficient time to review this version.

[14] Several additional code files are included with the December 7 release. These files will require further review. It is unclear whether they will resolve some of the concerns regarding accessibility of the Model.

confusion, each beta version released for public examination should be accompanied by a beta number. This numbering system would indicate that the Model has not been substantially changed, but would give the user the information necessary to insure the use of the most recent model.

- Documentation describing each algorithm (including the formula used or performed) and a description of the sequential flow of the algorithms in the Model for each module (*e.g.*, cluster, distribution and feeder) and the Model Interface.

- Documentation describing the interactions between the different parts of the Model (*e.g.*, modules, input tables, module outputs, work sheets) that the Model Interface is designed to automate and/or control.

30. Given the numerous undocumented FCC Model iterations, the missing database and input values, and the many other open issues, the FCC Model is clearly a work-in-progress. An explicit and comprehensive industry-wide review of the FCC Model can be undertaken only when the Model is complete.

THE FCC MODEL DOES NOT SATISFY THE *UNIVERSAL SERVICE ORDER'S* CRITERIA FOR FORWARD-LOOKING COST MODELS.

31. The *Order* explicitly states that the FCC model needs to comply with the *Universal Service Order's* criteria for forward-looking cost models. While a full analysis of the Model's compliance with the criteria is not possible at this time

due to the unfinished state of the FCC Model,[15] the current version appears to fail several of the criteria. In addition, several criteria are concerned with input issues, which are not encompassed by the *Order*. Thus, the following discussion focuses on platform-related issues only.

32. Criterion One requires that:

(1) The technology used must be the least-cost, most-efficient, and *reasonable* technology that is currently being deployed.

(2) The ILECs' wire centers must be the center of the loop network and outside plant should terminate at *ILECs' current wire centers*.

(3) The loop design *should not impede* the provision of advanced services.

(4) Wire center line counts should equal *actual* ILEC wire center line counts, and the average loop length should reflect the ILECs' *actual* average loop length.

On a theoretical level, the least-cost criterion stipulates that the costs (expenses and investments) should be those incurred by a cost minimizing firm under the constraint of producing a given level of output. In its calculation of cost output, however, the FCC Model does not properly model the tradeoff between investments and expenses because it determines expenses after an independent determination of investments. Therefore, any miscalculation in investments will lead to a miscalculation of expenses because expenses in the FCC Model depend largely on calculated investments. The Commission recognized this problem with other cost proxy models when it noted that neither

[15] Until the Model is operational, which includes among other things inputs, the results cannot be validated.

the BCPM nor the HAI Model "seeks to minimize the total lifetime cost, including maintenance, of outside plant structure mix."[16]

33. Criterion Two states that any network function or element necessary to produce supported services must have an associated cost. The FCC Model accounts only for the major network elements. As detailed in the Murphy Affidavit, the FCC Model does not include many costs necessary to provide supported services. For example, the FCC Model does not properly account for Operations Support Systems ("OSS") costs. Another example is that the FCC Model also does not include necessary testing investment.[17] In totality, the FCC Model assigns associated costs to all of the major network elements, such as loop, switching, transport, and signaling. However, the major elements are comprised of sub-elements (*e.g.*, OSSs and testing equipment) and the FCC Model ignores many of these sub-elements.

34. Criterion Three directs that only long-run forward-looking economic cost may be included. That is, the time period used must be long enough that all costs may be treated as variable and avoidable, and the costs used must not be the embedded cost of facilities, functions, or elements. The FCC Model confuses two different notions of the long-run. The first notion is static. In a static notion,

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[16] Federal-State Board on Universal Service; Forward-Looking Mechanism for High Cost Support for Non-Rural LECs, *Further Notice of Proposed Rulemaking*, CC Docket Nos. 96-45, 97-160, FCC 97-256 (rel. July 18, 1997) at ¶ 56.
[17] *See* Murphy Affidavit.

a firm minimizes the costs of a predetermined output level with a predetermined most advanced technology and the current prices. The static notion solves a simple static optimization problem for *one* period, however long or short and then extrapolates the answer over time. This use of the static notion is very limited. Specifically, it is not cost-minimizing over time and fails the concept of least-cost. The second notion is dynamic. The dynamic notion recognizes that technologies will change, input prices will change, and outputs will change. The dynamic notion minimizes the present discounted value of cost over the planning horizon. The dynamic notion, as opposed to the static notion, correctly puts an optimal investment plan in place and, in each period, the non investment costs for production in that period are minimized. The FCC Model inappropriately mixes the static and dynamic notions. It attempts to solve a static problem using the dynamic notion. It does this by attempting to minimize a firms costs with varying technology, prices, and outputs. The only way this can be done is by picking one vector of input prices, one specific technology, and one level of outputs, and then extrapolating the results over time. Consequently, the FCC Model in its current state does not correctly estimate long-run forward looking economic costs and thus fails Criterion Three.

35. Criterion Six directs that the cost study or model must estimate the cost of providing service for all businesses and households within a geographic region. This includes the provision of multiline business services, special access and

private lines, and multiple residential lines. The inclusion of multiline business services and multiple residential lines will permit the cost study or model to reflect the economies of scale associated with the provision of these services. The FCC Model does not appear to have facilities adequate to provide service upon demand for unoccupied or new locations. To date, geocoded data in the FCC Model includes occupied units with no adjustment factor for unoccupied units. Both the costs of building to these locations and the cost of properly sizing network components to meet forecasted demand are essential in estimating the long-run costs.

36. Criterion Eight mandates that the cost study or model and all underlying data, formulae, and computer software should be available to *all* interested parties for review and comment. All underlying data should be verifiable, engineering assumptions reasonable, and outputs plausible. The FCC Model does not satisfy this criterion because it is missing complete and documented source code; has incomplete documentation; is missing a list defining each variable and how and where it is used; is missing a tracking option in its code that would allow the user to track through the code and understand how certain variables are being used; has no input database; has no customer location input database (geocoded database); and is missing input values for each of the variables.[18]

[18] As previously mentioned in note 13, the December 7 release further expands the available documentation and source code. However, a complete review of a final version is required to provide a comprehensive critique of the Model.

37. Criterion Ten states that the cost study or model must deaverage support calculations to the wire center serving area level at least and, if feasible, to even smaller areas, such as a Census Block Group, Census Block, or grid cell. The FCC Model reports support calculations at the wire center or density-zone level. However, it does not deaverage beyond the wire center level. While this does, in the strictest sense, fulfill the criterion, it would be greatly improved if high cost regions could be identified on a smaller level than the wire center.

THE FCC MODEL DOES NOT ADHERE TO SOUND ENGINEERING AND FORWARD-LOOKING, COST MINIMIZING CRITERIA.

38. The FCC Model is subject to the fundamental limitations of any cost proxy model. Cost proxy models forecast the costs for a hypothetical, single "most-efficient firm" entering the entire market instantaneously. As such, they do not, and cannot, produce the forward-looking minimum costs that duplicate those incurred by either an incumbent or a competitive local exchange carrier. Consequently, the FCC Model does *not* produce the forward-looking economic costs of any real carrier that would compete in the local exchange marketplace. At most, the FCC Model identifies geographic areas that are relatively high or low cost to serve; *i.e.*, it provides benchmarks of how expensive one area is relative to another.

39. Further, the FCC Model attempts to minimize investment costs and, as a result, does not produce a cost optimized result. Actual firms seeking to minimize costs

must make tradeoffs between initial investment costs and expenses over time. Firms seek the mix of plant that minimizes total lifetime costs—the net present value of initial investment cost, growth costs, and maintenance costs to provide service over time. The adopted Model does not do this.

40. Another limitation inherent to cost proxy models, and the FCC Model, is that they assume all demand is satisfied at one time. Growth and uncertainty are not accounted for, which results in understated costs. Developing a proxy model that adequately takes into account all the complex tradeoffs that real firms must take into consideration may not be achievable. It should, at least, build a network that is able to be augmented efficiently and cost effectively. Besides the above limitations, there are other weaknesses associated with cost proxy models and, as discussed in more detail below, render the adopted Model incomplete.

41. The industry widely echoes the concerns about the FCC Model and cost proxy models in general. First, the Federal-State Joint Board's most recent recommendation states:

> Without a complete forward-looking economic cost model, it is not possible for the Joint Board to make a final recommendation as to the most reasonable forward-looking methodology to be used in distributing federal high cost support to the states and/or carriers.[19]

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[19] Federal-State Board on Universal Service, *Second Recommended Decision*, CC Docket No. 96-45, FCC 98J-7 (rel. Nov. 25, 1998) at ¶ 28.

Next, it goes on to say:

> Because the Commission's cost proxy model results are not complete, our recommendation on using a model to estimate forward-looking costs is a *work in progress*, and therefore tentative.[20]

This clearly shows that even members of the Joint Board are extremely concerned with the direction being taken in this proceeding. Particularly convincing and economically sound is Commissioner Furchtgott-Roth's view point that "federal proxy cost models should not be adopted to distribute universal service subsidies, especially when the results of the model are not even known."[21] Similarly, Commissioner Schoenfelder states:

> At this time, we do not know what the results of the cost model will be. The Commission still must select the inputs to be used in the model. Without the opportunity to review the final result of the model, I do not believe we can make a determination that the model will provide a realistic estimate of the costs of providing the supported services.[22]

Further, Commissioner Ness states: "we will not use this tool unless it has achieved a level of accuracy, predictability, and openness that earns it broad acceptance."[23] It seems particularly telling that some Commissioners fully or partially object to the use of the FCC Model in its current state. There seems to be industry-wide agreement that the FCC Model is still in a developmental stage

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[20] *Id.* at ¶ 29 (emphasis added).¶

[21] Dissenting Statement of Commissioner Harold Furchgott-Roth, *Re: Federal-State Joint Board on Universal Service, Second Recommended Decision (CC Docket No. 96-45)*, November 24, 1998, at 1.

[22] Separate Statement of Commissioner Laska Schoenfelder Dissenting, *Second Recommended Decision*, CC Docket No. 96-45, FCC 98J-7, November 1998, at 1.

[23] Separate Statement of Commissioner Susan Ness, *Re: Federal-State Joint Board on Universal Service, Second Recommended Decision (CC Docket No. 96-45)*, November 23, 1998, at 1.

and must, at a minimum, be refined before it can be tested adequately.

42. Another severe limitation to the Model's use is the fact that it ignores actual costs. The FCC Model does not depict the *actual* costs of an actual local exchange carrier. Instead, it models the cost of a hypothetical carrier in a hypothetical world. Basing prices on hypothetical costs misstates the actual relationship between prices and costs and causes the wrong signals to be sent to the price system (on which efficient resource allocation in a market economy depends). Consequently, it distorts the entry, exit, and expansion decisions of market participants. A properly functioning market mechanism fosters more efficient relationships between prices and costs and sends the *correct* signals to guide the decision-making of those participants.

43. The actual costs that should be modeled are the current economic or opportunity costs of providing a given level of services, employing the existing technology. This technology will be a mix of the current and the new, all used and useful. If necessary to achieve appropriate service levels, the economic costs will include, at the margin, the cost of new equipment of the most technically advanced variety. Any model attempting to determine the costs of providing service must be judged on the basis of how well it approximates the actual costs of an actual efficiently run firm.

44. In addition, modeling of a technology for use in a cost proxy model must be complete. This means that sufficient outside plant exists to accommodate

business-as-usual growth and churn and adequate excess switching capacity to handle accelerating holding times caused by increased Internet usage. It also means the lines must be of a type and condition to handle high-speed modem traffic. Further, all services provided by a firm must be modeled at an acceptable level. This means besides the usual outputs of lines, minutes-of-use, and the like, the model must allow for the provision of acceptable service intervals, repair intervals, and blocking probabilities. The *Order* spells this out when discussing the *Universal Service Order's* criteria: "maintaining a specified level of network performance quality."[24] The FCC Model does not appear to provide sufficient facilities *in each stage of switching*, which is required to provide a satisfactory grade of service during periods of maximum demand (*see* Murphy Affidavit). Other aspects of the FCC Model's compliance with the modeling of a technology can only be investigated when the Model is completely finished.

45. As stated in the Murphy Affidavit (at ¶ 51), "TELRIC/TSLRIC principles require that the total of all services/elements be studied. This insures that all economies of scale are captured and that the service or element being costed (e.g., in this case USF POTS lines) share these economies." Indeed, the calculation of total element or total service LRICs requires that all customers are served and that all elements or services are accounted for. A network that provided service only in high cost areas would not reflect the scale economies made possible by the fact

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[24] *Order* at ¶ 44.

that the high cost areas are part of a larger network. A network designed to provide only certain services will not be able to take advantage of the economies of scale or scope available in a full-service network. In addition, the proper accounting of any common costs requires that all services be considered. Thus, only after the total network has been constructed can a subset of services and/or customers be costed.

A PRELIMINARY ANALYSIS OF THE FCC MODEL'S ALGORITHMS REVEALS A NUMBER OF QUESTIONS AND CONCERNS.

The Clustering Module

46. The FCC Model provides a choice of clustering mechanisms based on two approaches—the divisive approach and the agglomerative approach.[25] The divisive approach begins with one "parent" cluster and subsequently divides the parent into smaller clusters. The agglomerative approach begins with each customer location belonging to its own unique cluster. The unique clusters are then merged into larger clusters according to one of two methods for distance measurement—the standard agglomerative approach or the nearest neighbor approach.

47. The Commission staff states that:

> [a] fixed cost gives a clear incentive to create a small number of large clusters, rather than a larger number of smaller clusters. On the other hand, with fewer clusters, the

[25] The Commission staff uses one method of the divisive approach and two methods of the agglomerative approach.

> average distance of a customer from a central point of a cluster, and consequently, the variable costs associated with cable and structures will be larger. In moderate to high density areas, it is not clear, *a priori*, what number of clusters will embody an optimal tradeoff between these fixed and variable costs. However, in low density rural areas, it is likely that fixed costs will be the most significant cost driver. Consequently, a clustering algorithm that generates the smallest number of clusters should perform well in rural areas.[26]

It is unclear whether fixed costs actually are large drivers, and no analysis is provided to suggest that they are more significant in rural areas. In developing a cost model, the main driver in selecting a clustering mechanism must be accuracy. If the resultant clusters do not accurately represent groups of customers that will likely share common structure, then the costs associated with the common structure (plus any fixed costs) will not be accurately measured. Also, if the resulting clusters are at odds with how the actual network is configured, that would further suggest that clustering is being done improperly. It is important to recognize that different clustering techniques lead to entirely different clusters, which results in different costs.

48. There are many available and accepted approaches for cluster analysis.[27] While not all of these methods would be suited to analyzing the customer location data

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[26] C.A. Bush, D.M. Kennet, J. Prisbrey and W.W. Sharkey, "The Hybrid Cost Proxy Model Customer Location and Loop Design Modules," August 19, 1998, at 5-6.

[27] A commonly cited reference on the subject of cluster analysis suggests several major families of clustering methods: (1) hierarchical agglomerative; (2) hierarchical divisive; (3) iterative partitioning; (4) density search; (5) factor analytic; (6) clumping; and (7) graph theoretic. *See* Mark S. Aldenderfer and Roger K. Blashfield, *Cluster Analysis*, Sage Publications (1984) at 35.

in the FCC Model, it is unclear why only three methods (falling into only two classes) have been considered. It further is unclear why the fact that the divisive method produces the smallest number of clusters is sufficient reason to make it the default,[28] especially since such a limited number of potential methods have been considered.

49. Several other clustering approaches are available. Each approach has advantages and drawbacks, depending on the specifics of the data being analyzed and the variables on which clustering is to be focused. As often happens when several alternative methodologies are available, there are tradeoffs involved in choosing any particular method over the others. The Commission staff states that "the divisive algorithm, has substantial advantages over both the agglomerative algorithms, because it tends to create the smallest number of clusters and is also by far the most efficient algorithm in terms of runtime."[29] However, as was demonstrated previously in GTE's Comments of August 28, 1998,[30] GTE's analysis does not confirm this result. Indeed, in several cases the divisive approach resulted in more clusters than the other methods and took approximately the same runtime.

50. It also is not clear exactly what tradeoffs the Commission staff is making with

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[28] *See Order* at ¶ 53.
[29] C.A. Bush, D.M. Kennet, J. Prisbrey and W.W. Sharkey, "The Hybrid Cost Proxy Model Customer Location and Loop Design Modules," August 19, 1998, at 6.
[30] *See* Comments of GTE, Federal-State Joint Board on Universal Service, Forward-Looking Mechanisms for High Cost Support to Rural LECs, CC Docket Nos. 96-45 and 97-160, DA 98-1587, dated August 28, 1998.

respect to runtime. As described above, the Commission staff says that runtime plays a large role in the selection of clustering mechanisms and in the decision to use raster points rather than actual customer locations. However, the staff provides no specific information regarding runtimes. Thus, it is difficult to make an evaluation as to the role which runtime should play. Further, data should be made available for evaluation on the degree to which runtime can be reduced with these various "short cuts."[31]

51. Clustering literature also discusses the reliability of certain clustering algorithms,[32] in particular, a "breaking down" methodology, which is similar to the divisive approach favored by the Commission staff. This analysis suggests that several factors can contribute to unreliable clustering results, including the level of numerical precision possessed by the running computer and the order in which the data are read into the computer.[33] Tests of the sensitivity of the FCC Model's clustering results to such differences should be conducted. Similarly, the tradeoffs related to runtimes also may be tied to runs on a particular machine. Decisions based on such tradeoffs likely would change if powerful

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[31] Literature on clustering analysis suggests a number of tests to assess the accuracy of clustering mechanisms. One paper suggests three statistics that can be used to test whether clusters generated by a clustering algorithm differ significantly from randomly determined groups of the same size. This paper emphasizes that in general several evaluation procedures should be used to assess any grouping scheme. (*See* T.D. Klastorin, "Assessing Cluster Analysis Results," *Journal of Marketing Research,* 20 (February 1983) at 92-98.) It does not appear that any such testing has been conducted on the HCPM clustering methods and, most likely, the model adopted by the Commission.

[32] *See* G. Ray Funkhouser, "A Note on the Reliability of Certain Clustering Algorithms," *Journal of Marketing Research,* 20 (February 1983) at 99-102.

[33] Other factors also can cause unreliable clustering results.

computers were available to run model variations more quickly.

52. The clustering methods used by the HCPM, and now the FCC Model, certainly deserve significant further analysis. Not only should the selected method produce most efficient clustering, but also must adhere to engineering standards and procedures. Unfortunately, the user does not have enough information to evaluate the developer's statements about preferred methods and defaults.

53. The current version of the FCC Model prevents the user from examining the effects of the different available clustering techniques. When run in batch mode, the optimization is set on auto-select and the algorithm is divisive. The interface indicates the ability to change the optimization technique, the algorithm, the raster size, and several other factors of clustering. However, the only method available for the user to change these options is to run the FCC Model in demo mode. While the demo mode does run the model, no output is saved. Future modifications should allow the user to both adjust the clustering options and to fully examine the effects of such changes. Since different clustering techniques produce different costs, it is important that the user be allowed to validate the methodology employed by the Model to ensure that the clusters produced are both reasonable and accurate.[34]

[34] The December 7 version of the Model allows the user to adjust the clustering inputs and optimization techniques. The fact that this option only recently became available underscores the need for adequate time to review a finalized version of the Model before any permanent decisions are made.

Distribution and Feeder Module

54. The FCC Model needs to be subjected to a Minimum Spanning Tree ("MST") test. Much of the debate on the adequacy of a universal service cost proxy model is centered on how the model determines the local distribution network.[35] It is recognized that the current network may not be the most efficient for serving today's known demand. The current network was constructed incrementally over time as demand grew rather than being optimally configured at inception for the current number and location of customers. Therefore, instead of costing the current distribution network, cost proxy models construct a hypothetical network that links customers to wire centers. The location of customers and the layout of the network, which connects the customers to the wire centers, have a significant impact on estimated costs because these assumptions affect the outside plant investment.

55. In the HAI Model, it was shown that the algorithms used to determine distribution areas and required facilities produced results that underestimated the outside plant investment needed to link customers to the wire centers. This conclusion was established empirically by comparing the HAI Model's distribution network to an MST. An MST is a mathematical graph theory construct used to connect a

[35] The local distribution network is a component of the local exchange network. It addresses the portion of the network extending from Serving Area Interfaces ("SAIs"); *i.e.*, the interconnect points between feeder and distribution cable, to the customers' premises.

set of points at the least possible length of total connecting lines.[36] An MST by definition leads to the shortest distance possible to connect a set of points. In reality, however, it is seldom that this absolute minimum is achievable. Due to physical obstacles (mountains, waterways, roads) and right-of-way issues in the real world, the achievable shortest length is usually significantly greater than an MST. This is why the MST should be used *only* as a reality check lower-bound measure—not as the actual amount of cable required. As a measure of the overall reasonableness of its outputs, a similar procedure needs to be performed on the FCC Model's results. For each cluster, the total cable length inferred by the MST needs to be calculated and compared with the length produced by the FCC Model. If the lengths in the FCC Model are less than those of the MST, this implies that the FCC Model provides less distribution cable than required physically to connect customers to the network, hence lower costs. While such analysis is very desirable to perform, it can only be done if the database is available and completely open for review. Since this currently is not the situation, the actual analysis must be deferred until the data exist. Thus, the Commission should defer adopting a model until the above described analysis can be performed on the FCC Model and it is shown to properly model loop plant.

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[36] *See* N.L. Biggs, *Discrete Mathematics*, Clarendon Press, Oxford (1994); *see also* J.E. Flood, ed., *Telecommunication Networks*, IEEE Telecommunication Series 1, Section 13.4 (1977).

Expense Module

56. The FCC Model is to incorporate a modified version of the HAI Model's expense module in the interest of administrative efficiency.[37] The Commission's goal should not be administrative efficiency, but the most realistic estimate of costs. Further, any testing performed by the Commission on the HAI Model that confirms that it produces accurate results should be made public. Experience with the expense module in the HAI Model does not reflect the production of realistic estimates of expenses. Finally and perhaps most important, while the factors in the HAI Model are assumed constant for an ILEC, the FCC Model should vary them based on the size of the ILEC—at the very least.

Model Output

57. From an economic perspective, the key criteria in evaluating a model's appropriateness must be accuracy and reasonableness. A model that cannot produce consistently accurate cost estimates is useless and, if implemented as policy, an inaccurate model could impede future competition. The accuracy of a model's results can and should be tested. A common mechanism for testing a model's outputs is to compare them with actual, reported data. A comparison to actual, unadjusted, cost levels can serve as an excellent starting point for estimates of forward-looking costs, and can serve as a standard of comparison

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[37] *See Order* at ¶ 91.

for external validity checks.[38] Further, the Commission staff recognizes the usefulness of such a comparison: "[i]t may also be instructive to compare estimates calculated by the models with data from Automated Record Management Information Systems ('ARMIS')."[39]

58. The preliminary nature of the FCC Model prevents a final external validity check. The modelers continue to make changes in algorithms and inputs that may have a substantial impact on cost estimates. Most important, the FCC Model currently lacks a complete and verifiable customer location database. The modelers have provided a mock database, allowing users to examine the functions of the Model, but not its accuracy. The FCC Model's results are available for a limited number of study areas. In all cases, a third party provided the Model output. Because the customer location database remains inaccessible and the exact specifications used for the analysis are not provided, the results of these studies may only be considered a guideline for the types of results produced by the FCC Model.

59. GTE purchased the FCC Model's customer location module output for three study areas within its Pennsylvania operations, referred to as "GTE," "Contel,"

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[38] Economists routinely employ such models to study the cost characteristics of a firm or industry. For example, Professor David Kasserman, testifying on behalf of AT&T cited an econometric study of telephone company historical costs in support of his assertion that local exchange service is not a natural monopoly. *See* Richard Shin and John S. Ying, "Unnatural Monopolies in Local Telephone," *Rand Journal of Economics*, Vol. 23 (1992) at 171-183.

[39] Jay Atkinson, Chris Barnekov, David Konuch, William Sharkey, "The Use of Computer Models for Estimating Forward-Looking Economic Costs – A Staff Analysis" (January 9, 1997) at 6.

and "Quaker State" and compared the dollar investment and expense predicted by the FCC Model to those reported in 1996 ARMIS 43-02, 43-03, 43-04, 43-07, and 43-08 by GTE North – Pennsylvania.[40] GTE's analysis revealed that the HCPM cost estimates suggest that in a forward-looking environment, "GTE" should incur 53 percent of its current Telephone Plant in Service ("TPIS") cost and "Contel" should incur 63 percent of its current TPIS costs. This same comparison for "Quaker State" reveals an estimate of 105 percent of current TPIS costs. A nearly 40 to 50 percent reduction in investment costs is beyond reasonable expectations. Similar results were found when examining operating expenses. Both "GTE" and "Contel" are expected to make more than 50 percent reductions in future operating expenses. These results cast serious doubt as to the accuracy of the current version and suggest that changes are needed to produce reasonable results.

The Geocoding Database

60. The customer location database should contain the actual line counts associated with each wire center.[41] The FCC Model's mock database indicates the inclusion of residential and business lines at each customer location. Whereas, the final database should closely approximate actual line counts and, if possible, should include data on special, public, and inactive lines. As it now stands, the FCC

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[40] This analysis is very rough as GTE was required to use the "mock" default values in the Model and the PNR data.

[41] This is a Criterion One requirement. *See Universal Service Order* at ¶ 250.

Model's database and algorithms may underestimate actual line counts. As previously stated, the FCC Model lacks an appropriate customer location database. In the absence of this database, the Commission has suggested analyzing the FCC Model using the PNR database. Following the Commission's suggestion, GTE obtained from PNR a sample output for its operations in Pennsylvania. While the customer location database is not available, the line counts indicated in the output do cause concern. Among the 117 wire centers included in the study areas, 53 percent (62 wire centers) exhibited business line counts that differed by more than 10 percent from GTE's actual business line counts. Special access lines differed by more than 50 percent in 62 wire centers (53 percent). Also inaccurate were single line business counts, underestimating lines by more than 50 percent in 97 percent of wire centers. While line counts should not be expected to match exactly, as the dates of the counts may not be identical, the wide disparities between actual and estimated line counts are absolutely unacceptable. The universal service fund size is calculated based upon the number of residential and single line business lines. Failure of the Model to properly account for all lines will cause a drastic underestimation of the fund size. This also reinforces why the Commission should not adopt a model that cannot be completely verified and validated.

61. The effects of optimization techniques on line densities cannot be examined. Restrictions currently exist within the FCC Model preventing the user from

obtaining data using different clustering optimization techniques.[42] It is possible that the various potential assignments to clusters will alter the distribution of lines across density zones, altering costs. Further examination of this issue also is required to evaluate the FCC Model.

[42] In the December 7 release, the Model allows the use of various clustering optimization techniques. Insufficient time prevented any analysis of the newest release of the Model.

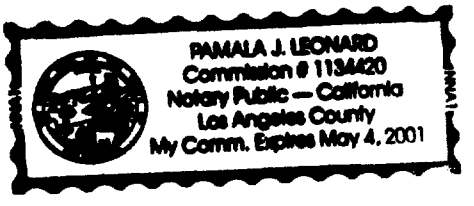
I hereby swear, under penalty of perjury, that the foregoing is true and correct.

Christian Michael Dippon

Subscribed and sworn to before me this 17th day of December 1998.

Notary Public

My Commission Expires: May 4, 2001



APPENDIX A

Evolution of the FCC Model's Customer Location Module[1]

Version	Release Date	Primary Modules	Notes	Changes and Modifications
HCPM 1.0	10/31/97	CENBLOCK.exe FEEDDIST.exe	Internet download	Customer location approach only. Census block grid approach (microgrids).
HCPM 2.0	12/29/97	CENBLOCK.exe FEEDDIST.exe	Internet download	Customer location approach only. Adjustments appear limited to changes within each module in response to Commission and other parties' comments.
HCPM 2.5	02/06/98	CENBLOCK.exe FEEDDIST.exe	Internet download	Customer location approach only. Adjustments appear limited to changes within each module. These changes include but are not limited to an adjustment to the feeder algorithm.
HCPM 2.5a	02/19/98	CENBLOCK.exe FEEDDIST.exe	FCC deadline for changes.	Minor adjustments to HCPM 2.5.
HCPM 2.6	7/20/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe		Customer location approach only. This version uses geocoded data, a new interface and allows the user to submit the HCPM output for processing by modified switching and expense modules of HM 5.0a.

[1] This table represents the HCPM versions circulated by the FCC web site, e-mail, and CD ROM. Minor inconsistencies exist between these dates and the official release dates in the latest version of the Model Documentation. The HCPM 2.5a is not included in the Model timeline. This version was released on CD ROM, dated February 19, 1998. Several apparent versions of the HCPM 2.6 also are not mentioned in the Model timeline. The module modification dates indicate that modifications were made to the HCPM on or about August 13, August 18, September 16, October 9, and October 16, 1998. None of these releases are included in the official timeline, which further complicated the analysis of this model.

Version	Release Date	Primary Modules	Notes	Changes and Modifications
HCPM 2.6	8/13/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe	Internet download	Customer location approach only. Unknown modifications
HCPM 2.6	8/18/98	HCPM-HAI interface HCPM-BCPM interface		Customer location approach only. HAI interface allows the outputs of the HCPM clustering, distribution and feeder modules to be incorporated into the HAI Model, Version 5.0a for further processing by that model's switching, transport and expense modules. BCPM interface is a "dual mode" BCPM interface that will allow the user to run either the HCPM loop logic and clustering or the BPCM loop logic and grids.
	9/16/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe	Internet download	Customer location approach only. Unknown modifications
	10/09/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe	PNR e-mail	Customer location approach only. Unknown modifications

Version	Release Date	Primary Modules	Notes	Changes and Modifications
	10/16/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe	Internet download with override from Commission staff e-mail.	Customer location approach only. The replaced files include CLUSINTF.exe, FEEDDIST.exe, and several source code files.
FCC Model[2]	11/18/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe	Internet download for the customer location portion (previously HCPM).	This version includes additional guidance and files for the HCPM/HAI interface. Missing: modified HAI switching, transport, interoffice and expense module, and customer location database.
FCC Model	12/7/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe	Internet download for the customer location portion (previously HCPM).	Apparent changes to model documentation, interface and customer location module.
	12/17/98	HCPM.exe CLUSTER.exe CLUSINTF.exe FEEDDIST.exe	Internet download for the customer location portion (previously HCPM).	Largely unknown. Model seems self-installing and includes some more documentation.

[2] These are the HCPM modules that were incorporated into the FCC Model in a modified version. The FCC Model also includes other modified modules from different models that are not shown here. It is important to note that a full analysis is needed on the combination of modified modules.

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Christian Dippon received a Master of Arts in Economics from the University of California at Santa Barbara. Prior to joining NERA, he was an analyst at BMW's operations in Bangkok, Thailand, working on a variety of economic analysis and strategic planning issues.

Since joining NERA, Mr. Dippon has worked extensively on economic cost model analyses, market-share and market-power studies, market entry and exit and the assessment of competition in the telecommunications industry. He has analyzed and designed cost studies for telecommunication services and elements and determined reasonable TE/TSLRICs that meet competitive standards, are consistent with the FCC's guidelines and provide the client with a strategic management tool. Mr. Dippon has also conducted highly advanced market-share and market-power studies employing the latest qualitative choice model techniques and marketing surveying tools. Based on the result of these studies, Mr. Dippon has advised his clients on strategic management and policy issues. Mr. Dippon has appeared before various public utilities commissions as a subject matter expert, and prepared testimony, papers and expert reports detailing the results of NERA's analysis.

EDUCATION

UNIVERSITY OF CALIFORNIA, SANTA BARBARA (DECEMBER 1995)
Master of Arts in Economics
G.P.A. 3.64

CALIFORNIA STATE UNIVERSITY, HAYWARD (AUGUST 1993)
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PROFESSIONAL EXPERIENCE

NATIONAL ECONOMIC RESEARCH ASSOCIATES, INC., Los Angeles, CA

1998- ***Senior Analyst***
1998-1998 ***Economic Analyst***
1996-1998 ***Associate Analyst***
Works mainly on market research projects, regulatory cases on issues of pricing policy, total factor productivity, assessing demand for new and existing products/services and the assessment of competition in the telecommunications industry. Analyzed economic cost models related to regulatory and strategy issues and performed econometric demand analysis methods for telecommunications and other industries. Co-authored, coordinated, and supervised the preparation of testimony, expert reports, and arbitration documents.

BAVARIAN MOTOR WORKS, BANGKOK, THAILAND

1993-1994 ***Analyst***
Managed and assisted in a multitude of managerial projects such as the economic and financial analysis of the operations in Thailand, the strategic planning and forecasting to the year 2000, and the development and implementation of various quality programs.

CALIFORNIA STATE UNIVERSITY, HAYWARD

1992-1993 ***Tutor***
Tutored undergraduate students economics, German language, mathematics, and history.

SWISS ARTILLERY, BIERE, SWITZERLAND

1989-1990 ***Corporal***

1989-1990 ***Soldier***

HONORS AND PROFESSIONAL TRAINING

- National Dean's List
- Golden Key National Honor Society
- Dean's Honor Roll for the academic year 1991-1992

- Qualitative Choice Workshop, UC Berkeley, 1996
- Advanced Qualitative Workshop, UC Berkeley, 1997
- Time Series Workshop, UC Berkeley, 1998
- Fundamentals in SAS, The SAS Institute, 1997
- Introduction to Visual Basics 5.0, 1997
- Telecommunications Engineering, TRA, 1997
- Senior Writing Seminar, NERA, 1998
- Business Development Strategy and Skills, Carlson Associates, 1998

LANGUAGES

- Fluent in German (native language)
- Fluent in English
- Fluent in French
- Proficient in conversational Thai and Spanish

COMPUTER SOFTWARE

- Window 95
- Office 97
- SAS
- Visual Basics 5.0
- Map Info 4.12
- Corel Suite 8.0

AFFILIATIONS

- American Economic Association

SELECTED CONSULTING REPORTS AND TESTIMONIES

Economic and Algorithmic Errors in the Hatfield Model, Release 3.1 With Dr. Gregory Duncan, Dr. Timothy Tardiff, and Dr. Rafi Mohammed. Expert report prepared for GTE Corporation in interconnection arbitrations in various states.

Economic and Algorithmic Errors in the Hatfield Model, Release 4.0 With Dr. Gregory Duncan, Dr. Timothy Tardiff, and Dr. Rafi Mohammed. Expert report prepared for GTE Corporation in interconnection arbitrations in various states.

Evaluation of the Hatfield Model, Release 5.0 With Dr. Gregory Duncan, Dr. Timothy Tardiff, Dr. Rafi Mohammed, Mr. Francis Murphy and Mr. Robert Cellupica. Expert report prepared for GTE Corporation in interconnection arbitrations in various states.

Evaluation of HAI Consulting Inc.'s implementation of actual average loop length into HM 3.1. Prepared for GTE Northwest, Inc. in response to a bench request by the Washington Public Utilities Commission.

Affidavit of Christian Michael Dippon In Support of the Motion of Contel of Minnesota, Inc. d/b/a GTE Minnesota for Reconsideration of the Commission's Decision to Recommend HAI 5.0a. Before the Minnesota Public Utilities Commission, May 10, 1998.

The Cost of the Local Communication Network: A Comparison of Minimum Spanning Trees and the HAI Model. With Dr. Kenneth Train, University of California at Berkeley, June 12, 1998. (publication pending)

CONSULTING PRESENTATIONS AND SPEECHES

Dippon C. M.; Murphy F., "Economic And Engineering Errors in HM 3.1," presented before the Hawaiian Public Utilities Commission, Honolulu, HI, February 1998.

Dippon C. M.; Train, K., "The Cost of the Local Telecommunications Network: A Comparison of Minimum Spanning Trees and the HAI Model" presented at the Telecommunications Policy Research Conference, Alexandria, VA, October, 1998.

11/98